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(71)Applicant : MITSUBISHI MATERIALS CORP

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(72)Inventor : NISHIHARA AKIRA

HAYASHI TOSHIHARU

SEKIGUCHI MASAHIRO

(54) MANUFACTURE OF CONDUCTIVE OXIDE POWDER

(57)Abstract:

PURPOSE: To manufacture conductive oxide powder with good mass productivity, uniform properties, super fine granular shape with little unevenness, and low resistance.

CONSTITUTION: Raw materials (hydroxide and/or oxides, preferably hydrated hydroxides obtained by coprecipitation, dehydrated hydroxides and/or oxides of the hydrated hydroxides) for a conductive oxide composition consisting of two or more transition metals are heated at 350-1000°C in closed and pressured atmosphere of an inert gas (argon, helium, nitrogen, etc.) at 2kgf/cm² or higher. Consequently, ITO powder with particle size 0.05µm or smaller and volume resistivity 0.1Ω.cm or less is prepared by mass production.

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CLAIMS

[Claim(s)]

[Claim 1] It is the start raw material which consists of two or more sorts of the mixed water oxides and/or oxides of transition metals Pressure 2 kgf/cm² It is temperature under the pressurization inert gas ambient atmosphere which more than sealed. The manufacture approach of the conductive oxide powder characterized by heat-treating at 350-1000 degrees C.

[Claim 2] Said start raw material is (1). The water mixed water oxide obtained by the coprecipitation by the reaction of the water solution and alkali water solution containing two or more sorts of transition-metals ion, (2) The mixed water oxide which carried out stoving of this water mixed water oxide, and/or the mixed oxide which carried out heating dehydration, (3) The conductive oxide powder obtained by the well-known approach, and (4) The manufacture approach of the conductive oxide powder according to claim 1 chosen from the mixed powder of the water hydroxide of two or more sorts of transition metals, a hydroxide, and/or an oxide, and the group which becomes more.

[Claim 3] transition metals -- Sb and Sn of Sn and In -- or the manufacture approach of the conductive powder according to claim 1 which is the combination of aluminum, Sn, In, Fe, Ga, Co, Si, germanium, Sb, or Pb and Zn.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention -- tin doped indium oxide (ITO) Antimony doped tin oxide (ATO) etc. -- conductive oxide powder by the electronic conduction nature which is made into the example of representation and which consists of two or more sorts of mixed transition-metals oxides (n mold oxide-semiconductor powder) It is related with the manufacture approach.

[0002] This invention is the diameter 0.2 of a primary particle in more detail. It is 0.1 preferably below μm . It is below μm and, moreover, is a green compact. (50 kgf/cm²) A volume resistivity is related with the approach that the conductive oxide powder excellent in the transparency and conductivity of 10 or less ohm-cm can be manufactured by the approach excellent in mass-production nature. When especially the approach of this invention is applied to manufacture of ITO powder, 0.05 micrometers or less of diameters of a primary particle and a volume resistivity are 0.1. The conductive oxide powder of the low resistance and superfines called below omega-cm can be mass-produced.

[0003]

[Description of the Prior Art] water solution which contains two or more sorts of raw material transition-metals ion as the general manufacture approach of the conductive oxide powder of an electronic conduction genotype (an example --) Water solution which dissolved Sn and In as a chloride or a nitrate in the case of ITO powder It is made to react with an alkali water solution, coprecipitation of the hydroxide of a raw material metal is carried out, and there is the approach of heat-treating this in atmospheric air and transforming to an oxide by using this coprecipitation hydroxide as a start raw material. This approach is stable also about not only ITO powder but ATO powder, or the electronic conduction mold conductivity oxide powder of other others, and it is known that the submicron impalpable powder of low resistance can be manufactured.

[0004] As a field of the invention of the conductive oxide powder manufactured by such approach, it is the first [an average of] particle diameter, for example 0.1 Conductive paint which was distributed in the solution which consists of a solvent and binder resin, and coating-ized the conductive impalpable powder-like oxide powder controlled below to μm (coat formation material) It is. This coating can form the transparence electric conduction film on a base material by carrying out coating and drying with means, such as immersion, spreading, printing, a spin coat, or spraying, to base materials, such as glass and plastics.

[0005] This transparence electric conduction film is effective in electrification prevention of glass, plastics, etc., or antisticking of dust, for example, is used as an object for antisticking of electrification prevention of the windowpane of TV Braun tube or a measuring instrument, or dust.

[0006] Moreover, recently, use or examination is carried out to the application of electrification prevention of IC package circuit formation, clean room interior material, various glass, a film, etc., antisticking of dust, a spreading mold transparent electrode, or a field heating element, and, as for the impalpable powder of conductive oxide including ITO powder, the elongation of future need is expected.

[0007] With expansion of such use, the military requirement to conductive oxide powder is also increasing, and higher transparency and conductivity are searched for in the application which forms the transparent electric conduction film especially with the application of ITO powder with coating means, such as spreading and printing. For this reason, while examination of the distributed technique in coating-izing is performed, it gropes for the means of the further atomization and the reduction in resistance about the conductive oxide powder itself.

[0008] Conductive oxide powder by electronic conduction nature (n mold oxide semiconductor) An electric conduction device is In $2O_3$, when ITO is taken for an example. Operation of n mold donor by tetravalent Sn carrying out permutation arrangement to trivalent In site of a crystal (generating of a carrier electron) In addition, it is known that it is the main causes that the carrier electron density in bulk is raised by the donor effectiveness of the oxygen hole by the lattice defect. In manufacture of ITO, the oxygen tension of a firing environments is controlled or adjusting Sn content of a dope within the limits of 1 - 15 mol%, devising calcinating by the air current of reducibility, in order to raise the conductivity resulting from an oxygen defect more etc., and attaining low resistance-ization is known.

[0009] However, the upper part of the raw material prepared in the firing furnace by such approach (surface part) In the lower part, a difference arises in the ease of generating of an oxygen defect, and conductivity becomes an ununiformity. Therefore, in order to satisfy a super-particle and low resistance-ization to coincidence, it must cover with a brewing raw material as thinly as possible, and must calcinate at low temperature, but baking under such conditions produces a problem also to mass-production nature at the same time it produces dispersion in a property. For this reason, 0.05 micrometers or less of diameters of a primary particle and the volume resistivity which are demanded especially recently are 0.1. It was difficult the former to mass-produce industrially ITO low resistance and after superfines called below omega-cm.

[0010]

[Problem(s) to be Solved by the Invention] The purpose of this invention is the diameter 0.2 of a primary particle. It is 0.1 preferably below μm . It is below μm and, moreover, is a green compact. (50 kgf/cm²) A volume resistivity is offering the manufacture approach which can mass-produce the conductive oxide powder excellent in transparency and conductivity which is 10 or less ohm-cm.

[0011] For another purpose of this invention, 0.05 micrometers or less of diameters of a primary particle and a volume resistivity are 0.1. It is offering the manufacture approach of the conductive oxide powder which can mass-produce the ITO powder of low resistance and the shape of end of superfines below omega-cm.

[0012]

[Means for Solving the Problem] this invention person etc. is the raw material of conductive oxide powder. (two or more sorts of the mixed water oxides and/or oxides of transition metals) A header and this invention were completed for the ability of the above-mentioned purpose to be attained by heat-treating under the sealing pressurization conditions of inert gas.

[0013] It is the start raw material with which this invention consists of two or more sorts of the mixed water oxides and/or oxides of transition metals here Pressure 2 kgf/cm² It is temperature under the pressurization inert gas ambient atmosphere which more than sealed. Let the manufacture approach of the conductive oxide powder characterized by heat-treating at 350-1000 degrees C be a summary.

[0014] As a start raw material, it is (1). The water mixed water oxide obtained by the coprecipitation by the reaction of the water solution and alkali water solution containing two or more sorts of transition-metals ion, (2) The mixed water oxide which carried out heating dehydration desiccation and/or the mixed oxide which carried out heating dehydration of this water mixed water oxide, (3) The conductive oxide powder obtained by the well-known approach, or (4) The mixed powder of the water hydroxide of two or more sorts of transition metals, a hydroxide, and/or an oxide can be used.

[0015] Transition metals can apply this invention to manufacture and processing of the ITO powder which is the combination of Sn and In, the ATO powder which is the combination of Sb and Sn, and the conductive oxide powder of the zinc-oxide system which is the combination of aluminum, Sn, In, Fe, Ga, Co, Si, germanium, Sb, or Pb and Zn further.

[0016] The start raw material in the manufacture approach of the conductive oxide powder of [start raw material] this invention consists of two or more sorts of the mixed water oxides and/or oxides of transition metals. As this start raw material, it is (1). The water mixed water oxide obtained by the coprecipitation by the reaction of the water solution and alkali water solution containing two or more sorts of transition-metals ion, or (2) It is desirable from the effectiveness to super-atomization and the reduction in resistance being high to use the mixed water oxide and/or oxide which were obtained by stoving of this water mixed water oxide or heating dehydration.

[0017] However, (3) The conductive oxide powder obtained by the well-known approach, or (4) The mixed powder of the water hydroxide of two or more sorts of transition metals, a hydroxide, and/or an oxide can also be used.

[0018] Above (1) In order to obtain a water hydroxide, the water-soluble salt of two or more sorts of different transition metals is dissolved in water, and the water solution containing the ion of these transition metals is prepared. Although the class of water-soluble salt is not limited, organic-acid salts, such as acetate, are illustrated by inorganic-acid salts, such as a hydrochloride, a nitrate, and a sulfate, and the pan, for example. The mixture of two or more sorts of salts may be used. On the other hand, as an alkali water solution, it is alkali metal. (an example, sodium, or potassium) Or the water solution of the hydroxide of ammonium, a carbonate, and a hydrogencarbonate can be used. It is usual although especially the concentration of the water solution of a transition-metals salt and an alkali water solution is not restricted, either. 200 - 400 g/l It is within the limits.

[0019] It reacts by mixing two kinds of this water solution under stirring. Each transition-metals salt hydrolyzes by this reaction, and two or more sorts of transition-metals hydroxides coprecipitate. In order to obtain detailed precipitate, it is desirable for it to be dropped at the bottom of stirring of one water solution in the water solution of another side, and to mix gradually. Although what is necessary is for an experiment just to determine reaction temperature suitably since the ease of hydrolysis changes with the class of transition metals, concentration, amounts of dopes, etc., it is usually good within the limits of ordinary temperature -100 degree C. Although the amount of the alkali water solution used for a reaction changes also with classes of conductive powder, it is desirable to consider as the amount from which pH of the solution after mixing is set to 4-9. As long as it is required, stirring may be further continued after mixing.

[0020] If suitable means, such as sedimentation and filtration, recover precipitate, the mixed water hydroxide of two or more sorts of transition metals will be obtained. Precipitate may be rinsed before recovery or after recovery if needed. The water hydroxide obtained by this coprecipitation is the start raw material (1) of the approach of this invention as it is, without drying. It can be used by carrying out.

[0021] If stoving of the water mixed water oxide of two or more sorts of these transition metals is carried out, it will become a mixed water oxide, and it will become a mixed oxide, if heating is continued further and it dehydrates. The mixture of a hydroxide and an oxide is obtained depending on heating conditions. Thus, it sets to this invention and the mixed water oxide and/or oxide which were obtained are a start raw material (2). It can be used by carrying out. For these mixed water oxides and/or oxides, the diameter of a primary particle is 0.1. It is desirable that it is below μm .

[0022] If it limits only to desiccation, generally below 150 ** is preferably enough as whenever [stoving temperature] below 200 **. Although whenever [stoving temperature] can be carried out to a maximum of 900 ** when dehydrating and making it convert into an oxide, limiting to below 500 ** is desirable. If whenever [stoving temperature / at this time] is too high, grain growth will take place during heating and it will be easy to make big and rough the conductive oxide powder finally obtained. Although what is necessary is just to perform heating in atmospheric air, especially an ambient atmosphere is not restricted. As long as the desiccation or dehydration made into the purpose is attained, as for heating time, it is desirable to consider as a short time as much as possible. When dehydrating even an oxide especially, it is desirable to set up heating conditions so that grain growth may be prevented as much as possible.

[0023] Although what carried out heating dehydration of the water mixed water oxide which obtained this mixed oxide by coprecipitation as mentioned above when a start raw material was a mixed oxide is

desirable, it is said start raw material (3). As stated by carrying out, the conductive oxide powder itself obtained by baking of a hydroxide and/or an oxide can also be used as a start raw material by the well-known approach. For example, the above (1) Or the conductive oxide powder which calcinated and obtained the start raw material of (2) in the reducing atmosphere according to the well-known approach can be used as a start raw material of the approach of this invention. In this case, a powdered volume resistivity can be further reduced by applying this invention approach to this conductive oxide powder. [0024] Thus, also when using as a start raw material the conductive oxide powder obtained by the well-known approach, the first [an average of] particle diameter of this oxide powder is 0.1. It is desirable from effectiveness being high to super-atomization and the reduction in resistance in it being below μm . Particle diameter 0.1-0.2 When it becomes μm grade, even if it heat-treats under pressurization under an inert atmosphere according to this invention approach, it is uneven and there is no effectiveness in low resistance-ization not much. Moreover, particle diameter is 0.2. When μm is exceeded, it is difficult to make the transparency which was excellent in the dispersed system discover.

[0025] Furthermore, although it is not so desirable, it is a start raw material (4). It can carry out and the mixed powder of not coprecipitation but the water hydroxide of two or more sorts of transition metals which it was made to precipitate separately and were obtained, a hydroxide, and/or an oxide can also be used. Also in this case, the first [an average of] particle diameter is 0.1 like the above. It is desirable that it is below μm .

[0026] The combination of the transition metals in conductive oxide powder chooses the combination of a group who is mutually different in a periodic table. Namely, the transition-metals element of the oxide used as a parent and the element which can serve as a donor (transition-metals element which is in right-hand side from a parent element in a periodic table) Conductor choose combination and according to electronic conduction nature (n-type semiconductor) Constituting is common. The transition-metals element which serves as this donor is used so that it may become little to a base material transition-metals element as a doping agent.

[0027] As an example of the conductive oxide powder which can apply this invention approach suitably In 2O_3 ITO powder which doped Sn so that it might be set to $\text{Sn}/(\text{Sn}+\text{In})\text{mole-ratio}=0.01-0.15$, The ATO powder which doped Sb to SnO_2 so that it might be set to $\text{Sn}/(\text{Sb}+\text{Sn})\text{mole-ratio}=0.01-0.15$, and AZO powder which doped aluminum to ZnO so that it might be set to $\text{aluminum}/(\text{aluminum}+\text{Zn})\text{mole-ratio}=0.01-0.15$ (aluminum dope zinc oxide) etc. -- it is typical. that to which not only this but a doping agent raises conductivity (donor) it is -- if -- you may be what kind of thing and two or more sorts of transition-metals elements can also be doped. For example, ZnO It receives and one sort of Sn, In, Fe, Ga, Co, Si, Ti, germanium, Sb, and Pb or two sorts or more can be doped in addition to aluminum. Moreover, you may be the multiple oxide with which the oxide used as a parent also consists of two or more sorts of metallic elements, for example, it is ZnSnO_3 (stannic acid zinc). Doping agents, such as aluminum, In, Fe, Ga, Co, Si, Ti, germanium, Sb, or Pb, may be added to the conductive oxide powder produced from the gap of the stoichiometric composition of Zn and Sn which can be set, and this.

[0028] It is the start raw material of the [pressurization heating art by inert gas] above Pressure 2 kgf/cm^2 It is temperature under the pressurization inert gas ambient atmosphere which more than sealed. It heat-treats at 350-1000 degrees C. As inert gas, rare gas, such as an argon and helium, nitrogen, or these mixed gas can be used. Pressure [in / here / with a pressure / the room temperature of the pressurization ambient atmosphere] (total pressure) It means.

[0029] Heat-treatment is a well-closed container. (an example, sealing tube) In order to insert in a start raw material inside and to purge the oxygen in a container the container after the inert gas which uses the air in a container for an ambient atmosphere permuting or carrying out a vacuum deairing -- inert gas -- pressure 2 kgf/cm^2 it pressurizes above and seals -- a temperature up is carried out to the predetermined temperature within the limits of 350-1000 degrees C, and it can carry out by holding to this temperature.

[0030] Into an inert gas ambient atmosphere, as long as it is little in addition to inert gas, other gas may be mixing. However, if the oxygen tension in an ambient atmosphere exceeds 0.2 kgf/cm^2 (150 Torr), since about [not forming low resistance] and grain growth will also become remarkable, for mixing of

oxygen, oxygen tension is 0.2 kgf/cm². It controls so that it may become low. It is oxygen tension in order to heighten the effectiveness of the reduction in resistance, and atomization 0.02 kgf/cm². Considering as the following (15 Torr) is desirable.

[0031] For the pressurization conditions of heat-treatment, the pressures of an ambient atmosphere are 2 kgf/cm². What is necessary is just to be above. Baking in an inert atmosphere is among atmospheric air. (oxygen content ambient atmosphere) Although it is known as compared with baking that powdered grain growth will be accelerated, this invention is followed, and it is the pressure of an ambient atmosphere 2 kgf/cm². When it was the above pressurization ambient atmosphere, even if it was an inert gas ambient atmosphere, the grain growth under heat-treatment was suppressed and things became clear. and the upper part of the start raw material which the ambient atmosphere in a system was equalized and was prepared all over the firing furnace by considering as a pressurization ambient atmosphere (surface part) from -- it can apply to the lower part and low resistance-ization can be comparatively attained to homogeneity. Therefore, it is not necessary to cover with a start raw material thinly and to calcinate it, and a lot of start raw materials can be processed like before.

[0032] Pressures are 2 kgf/cm². Atomization serves as an uneven property in the upper part and the lower part of about [being difficult] and a raw material, and there is also almost no effectiveness of the reduction in resistance below. If the pressure of an ambient atmosphere is made into within the limits of 5 - 60 kgf/cm², since the above-mentioned effectiveness will increase further, it is desirable. If a pressure exceeds 60 kgf/cm², since the costs which pressurization takes in no longer accepting most improvements of effectiveness will increase, it is useless even if it applies a pressure more than this practically.

[0033] It is that what is necessary is just the temperature of heat-treatment, and within the limits of 350-1000 degrees C. It is within the limits of 400 - 800 **. If processing temperature is lower than 350 **, atomization cannot be formed into low resistance even if attained. On the other hand, when processing temperature exceeds 1000 degrees C, it is 0.1 during heat-treatment. Grain growth is carried out more than mum, and it becomes difficult to acquire the reduction in resistance and atomization. Although based on the relation between the brewing fill of a raw material, and temperature about the heating processing time, generally it is within the limits of 1 - 4 hours that uniform heat-treatment of a raw material should just be attained. It is not restricted about a temperature up and especially temperature fall time amount.

[0034]

[Example] Next, although this invention is explained based on an example, this invention is not limited only to an example.

[0035] [preparation of start raw material] start raw material -- the following (A) - (C) the water mixed water oxide prepared with the coprecipitation method, respectively is shown in Table 1 by the approach of a publication -- as -- as it is -- un-drying -- or it heat-treats, and dries or dehydrates.

[0036] (A) raw material of ITO powder (water hydroxide) InC13 Water solution (In metal 600g content) 1.8 -- L and SnC14 Water solution (30g content of Sn metals) a mixed water solution with 0.2 L -- the inside of the water solution of NH₄HCO₃ 3000g/12 L -- 70-degree C warming -- it was dropped stirring in the bottom, it was made last pH 8, and the In-Sn coprecipitation hydroxide was deposited. Next, after putting and making precipitate sediment, a supernatant is removed, ion exchange water is added and it is 6 times about actuation of standing and sedimentation, and supernatant removal. (the addition of water is 10L per time) After fully rinsing precipitate by repeating, precipitate was carried out the ** exception by suction filtration, and precipitate of a water hydroxide was obtained.

[0037] (B) raw material of ATO powder (water hydroxide) SnC14 Water solution (Sn metal 600g content) 1.8 -- L and SbC13 Water solution (80g content of Sb metals) a mixed water solution with 0.2 L -- the inside of the water solution of NaOH 900g/12L -- 90-degree C warming -- it was dropped stirring in the bottom, it was made last pH 7, and the Sn-Sb coprecipitation hydroxide was deposited. Then, the above (A) Precipitate was carried out the washing and ** exception similarly, and precipitate of a water hydroxide was obtained.

[0038] (C) Raw material of AZO powder (water hydroxide) ZnC12 1360g (Zn metal 652.3g content)

AlC13.6H₂O 125g (14g content of aluminum metals) It is dropped into dissolved 35-degree C water-solution 10L, stirring the water solution of Na₂CO₃ 1250 g/10 L, and is last pH 7. It carried out and the aluminum-Zn coprecipitation hydroxide was deposited. Then, the above (A) Precipitate was carried out the washing and ** exception similarly, and precipitate of a water hydroxide was obtained.

[0039]

[Table 1]

含水水酸化物	分類	調製した出発原料の状態
(A) ITO原料	A-1	含水水酸化物 (未乾燥)
	A-2	大気中110℃×15hr乾燥品
	A-3	大気中300℃×6hr脱水品
	A-4	大気中700℃×3hr脱水品
(B) ATO原料	B-1	大気中110℃×15hr乾燥品
	B-2	大気中500℃×3hr脱水品
(C) AZO原料	C-1	大気中110℃×15hr乾燥品
	C-2	大気中450℃×3hr脱水品

[0040] [Pressurization heat-treatment] pressurization heat-treatment is Incoloy 800 of bore 70 mm and die-length 700 mm. To the sealing pressurization tube furnace which used the make tube Raw material 250 g is put into the half-segmented quartz boat of die-length 250 mm, it inserts in, after purging the oxygen in a system with the used inert gas, a predetermined pressure is pressurized, and subsequently they are 8 degrees C / min. It carried out by carrying out a temperature up to predetermined temperature, and carrying out temperature maintenance for 3 hours. Processing conditions (an ambient atmosphere, a pressure, temperature) It is shown in Table 2.

[0041] About the first [an average of] particle diameter of the conductive oxide powder obtained by heat-treatment, it is specific surface area. (BET) Measured value to a (micrometer) = $6 / (\rho \times B)$ [a: Mean-particle-diameter, ρ : true-specific-gravity, and B: specific-surface-area (m²/g)] It computed based on the particle diameter type. In this way, the particle diameter for which it asked from specific surface area is mostly in agreement with the particle diameter which carried out direct observation from the transparency type electron microscope. BET The specific surface area by law was measured using the beta SOBU automatic surface area total 4200 molds by the micro truck company.

[0042] Moreover, volume resistivity of conductive oxide powder (50 kgf/cm² green compact) It asked using the Mitsubishi Petrochemical RORESUTA AP fine-particles resistance system. Measurement of a volume resistivity was separately performed about the sample extracted from the upper part and the lower part of a boat, and displayed the average. These test results are also collectively shown in Table 2.

[0043]

[Table 2]

	No.	原 料 分 類	加圧加熱処理の条件			特 性	
			雰囲気	圧 力 kgf/cm ²	温度 ℃	粒 径 μ m	体積抵抗率 Ω · cm
本 発 明 例	1	A - 1	N ₂	2	550	0.047	1.0 × 10 ⁻¹
	2	A - 2	N ₂	60	550	0.027	3.8 × 10 ⁻²
	3	A - 3	N ₂	30	600	0.036	2.3 × 10 ⁻²
	4	A - 4	A r	60	750	0.048	8.5 × 10 ⁻²
	5	B - 1	N ₂	20	800	0.064	8.0 × 10 ⁻²
	6	B - 2	A r	50	500	0.025	8.8 × 10 ⁻²
	7	C - 1	N ₂	10	400	0.032	5.0 × 10 ⁰
	8	C - 2	N ₂	70	350	0.035	7.1 × 10 ⁰
比 較 例	1	A - 2	N ₂	常圧	550	0.055	1.0 × 10 ⁰
	2	B - 1	N ₂	常圧	550	0.028	4.1 × 10 ⁰
	3	C - 1	N ₂	常圧	550	0.070	2.1 × 10 ³

[0044]

[Effect of the Invention] The examples 1-8 of this invention which are examples all formed the very detailed conductive oxide powder of low resistance so that the result shown in Table 2 might show. Moreover, the volume resistivity was uniform in the upper part and the lower part. On the other hand in the examples 1-3 of a comparison heat-treated under the inert atmosphere of ordinary pressure, the difference between figures double [1-] arose in the volume resistivity in the upper part and the lower part, and the volume resistivity itself was high the uneven top compared with the result in the example of this invention. Moreover, mean particle diameter also became larger than the example of this invention.

[0045] According to this invention approach, the first [an average of] particle diameter is 0.1. Below by mum, a volume resistivity is very low, a property is uniform, and a particle and low resistance conductivity oxide powder with little dispersion can be manufactured with sufficient mass-production nature. It is 0.05 micrometers or less in first [an average of] particle diameter so that it may understand also from the result of Table 2, in manufacturing ITO powder especially by this invention approach, and a volume resistivity is 0.1. It becomes possible to manufacture the low resistance superfines end of below omega-cm with sufficient mass-production nature. Consequently, the electrification prevention of glass, a film, etc. by applying the distributed ink using this powder to a base material and antisticking of dust are begun, it is expected that use of ITO powder will be expanded to a transparent electrode or a field heating element, and this invention contributes to use expansion of various conductive oxide powder including ITO powder.

[Translation done.]